Commanded Area and Irrigation Intensity

Commanded area is defined as the area that can be irrigated by canal.

Gross Commanded Area (GCA)

It is the total area (cultivable as well as uncultivable like ponds, roads, residential area, etc.), within the irrigation boundary of irrigation project, which can be economically irrigated considering that unlimited quantity of water is available.

Culturable/Cultivable Commanded Area (CCA)

- Culturable/cultivable part of gross commanded area (GCA).
- Includes all the land of GCA where cultivation is possible.
- At given time, all the cultivable land may not be under cultivation.
- Can be divided to *cultivated* and *cultivable but not cultivated* portion of CCA.

  CCA = GCA – uncultivable area
- In the absence of detailed data, CCA as 80% of GCA may be assumed.

Commanded Area and Irrigation Intensity

Net Commanded Area (NCA)

- Cultivable commanded area after **deduction** of area of canal network, ditches, bunds, etc. included in CCA.

  NCA=CCA – Canal Related Structures – non-irrigable areas.

Irrigation Intensity

- Percentage of the CCA purposed to be irrigated.
- *Seasonal Intensity of Irrigation* for a season and *Annual Intensity of Irrigation* for a year.
- Annual intensity of irrigation is summation of seasonal intensity of irrigation within a year

Commanded Area and Irrigation Intensity

For example,

If CCA of an irrigation field is 100 hectares, of which 60 hectares is cultivated in summer season and 50 hectares in winter season.

The Intensity of irrigation for summer is $60/100 \times 100\% = 60\%$

and winter will be $50/100 \times 100\% = 50\%$.

The annual intensity would result to $60\% + 50\% = 110\%$.

Duty, Delta and their relationship: Duty

Duty

- Duty of water is defined as the hectares of land that can be irrigated by a constant supply of water at one cumecs (m^3/s) throughout the base period (B).
- Represented by **D**.

For example,

If 3 cumecs of water supply is required for a crop sown in an area of 300 ha, then the duty of irrigation water = 300/3 = 100 ha/cumec

Duty, Delta and their relationship: Delta

Delta

The total depth of water, in cm, required by a crop to come to maturity is called delta (Δ).

If a crop requires 10 watering at an interval of 12 days and a depth of 8 cm in every watering then,

$$\begin{aligned} \Delta &= 10 \times 8 \\ &= 80 \text{ cm} \end{aligned}$$

$$\begin{aligned} &\textit{If}, \\ \text{Area} &= 50 \text{ hectare (ha)} \\ \text{Volume of water required} &= 50 \times 0.8 \\ &= 40 \; ha \cdot meter \end{aligned}$$

Relationship between duty and delta

Relationship between duty and delta

Consider a crop of Base period B days. Let one cumec of water be applied to this crop on the field for B days.

Water supplied to the field in 1 second	$= 1\ m^3$
Water supplied to the field in 1 day	$= 1 \times 60 \times 60 \times 24\ m^3$
Water suplied to the field in B days	$= 86400B\ m^3$
Volume (V)	$= 86400B\ m^3$

Relationship between duty and delta

By definition of duty, 1 cumec (m^3/s) supplied for B days matures D hectares of land.
This quantity of water (V) matures D hectares of land or 10^4 D m^2 of area.
Total depth of water applied on this land,

$$\Delta = \frac{Volume}{Area}$$

$$= \frac{86400\ B}{10^4\ D}$$

$$\Delta = 8.64\ \frac{B}{D} \qquad (11)$$

where B is in days and D is in hectares/cumec

Factors affecting duty of a crop

Factors affecting Duty of Crop

- **Type of crop:**
  Different crops have different water requirement thus different duty. Higher water requirement implies lower duty and vice versa.
- **Climate and season:**
  Losses are different in different season implying variation of duty.
- **Useful rainfall:**
  Higher useful rainfall means higher duty.
- **Type of soil:**
  High permeability of soil means higher water loss and lower duty and vice versa.
- **Efficiency of cultivation method:**
  If cultivation method is efficient then loss of water is less and duty is higher.

Methods of improving duty of water

Methods of improving duty of water

- Proper ploughing and levelling of land.
- Treatment of porous soil to reduce seepage.
- Leaching of alkaline soil before sowing.
- Adoption of modern cultivation methods.
- Chemicals can be used to increase water holding capacity of soil.
- Lining of canal.
- Rotation of crops.
- Lining of canal.
- Free flooding should be avoided as possible.
- Sub-surface or drip irrigation may be preferred.

Base period, kor period and kor depth

Crop Period

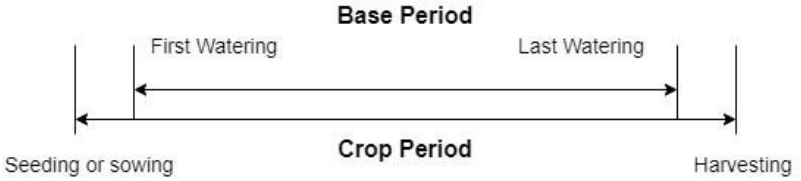
The time period that elapses from the instant of its **sowing** to the instant of its **harvesting** is called crop period and is expressed in days.

Base Period

Time between the **first watering** of a crop to the **last watering** before the instant of its harvesting is called Base period.

It is expressed in days and represented by B.

Figure: Base Period and Crop Period



Base period, kor period and kor depth

Kor period and Kor depth

- Generally, for all crops, first watering after the plant is few centimeters high is called **kor-watering**.
- It is usually maximum single watering followed by other watering at regular interval.
- The kor-watering must be done (applied) within fixed limited time called **kor-period**.
- Depth of water during this watering is called **kor-depth**.
- Since, water requirement is high, canal should have maximum discharge during this interval.
- They generally govern the discharge in canal.

Numerical

The culturable command area for a distributary channel is 10000 hectares. The intensity of irrigation is 30 per cent for wheat and 15 per cent for rice. The kor period for wheat is 4 weeks, and for rice 3 weeks. Kor watering depths for wheat and rice are 135 mm and 190 mm, respectively. Estimate the outlet discharge.

Numerical

Solution:
We know, Duty (in hectares/cumec):

$$D = 8.64 \frac{B}{\Delta}$$

where, B is in days, Δ is depth in meters.

Numerical

For rice,

$$
\begin{aligned}
D &= 8.64\,\frac{3 \times 7}{0.19} \\
&= 954.95\ \textit{hectares/cumec} \\
\textit{Cultivated area} &= \textit{Irrigation Intensity} \times \textit{CCA} \\
&= 0.15 \times 10000 \\
&= 1500\ \textit{hectares} \\
\textit{Discharge required} &= \frac{1500}{954.95} \\
&= 1.571\ m^3/s
\end{aligned}
$$

Numerical

For wheat,

$$
\begin{aligned}
D &= 8.64\ \frac{4 \times 7}{0.135} \\
&= 1792\ \textit{hectares/cumec} \\
\textit{Cultivated area} &= \textit{Irrigation Intensity} \times \textit{CCA} \\
&= 0.3 \times 10000 \\
&= 3000\ \textit{hectares} \\
\textit{Discharge required} &= \frac{3000}{1792} \\
&= 1.674\ m^3/s
\end{aligned}
$$

Here, both crops are in different season, so highest governs the discharge (In case some crops overlap and the sum of both governs discharge). So, required outlet discharge is **1.674** m^3/s.

Numerical

The cultivable command area (CCA) for a distributory is 1700 ha. The intensity of irrigation is 50% for Rabi and 30% for kharif crops. If a kor period for rabi crops is 4 week and kharif crops is $2\frac{1}{2}$ week calculate the discharge Take kor depth for rabi as 12 cm and kharif as 25 cm.

Numerical

Solution:
We know, Duty (in hectares/cumec):

$$D = 8.64 \frac{B}{\Delta}$$

where, B is in days, Δ is depth in meters.

Numerical

For rabi,

$$
\begin{aligned}
D &= 8.64\ \frac{4 \times 7}{0.12} \\
&= 2016\ \textit{hectares/cumec} \\
\textit{Cultivated area} &= \textit{Irrigation Intensity} \times \textit{CCA} \\
&= 0.5 \times 1700 \\
&= 850\ \textit{hectares} \\
\textit{Discharge required} &= \frac{850}{2016} \\
&= 0.422\ m^3/s
\end{aligned}
$$

Numerical

For kharif,

$$
\begin{aligned}
D &= 8.64\ \frac{2.5 \times 7}{0.25} \\
&= 604.8\ \textit{hectares/cumec} \\
\textit{Cultivated area} &= \textit{Irrigation Intensity} \times \textit{CCA} \\
&= 0.3 \times 1700 \\
&= 510\ \textit{hectares} \\
\textit{Discharge required} &= \frac{510}{604.8} \\
&= 0.843\ m^3/s
\end{aligned}
$$

Since, no information is provided on annual crops and Kharif has the highest discharge, the design discharge is **0.843** m^3/s.

Numerical

A stream of 130 liters per second was diverted from a canal and 100 liters per second were delivered to the field. An area of 1.6 hectares was irrigated in 8 hours. The effective root zone was 1.7 m. The runoff loss in the field was 420 m^3. The depth of water penetration varied linearly from 1.7 m at the head end of the field and 1.1 m at tail end. Available moisture holding capacity of soil is 20 cm per meter depth. It is required to determine the water conveyance efficiency, water application efficiency, water storage efficiency, and water distribution efficiency. Irrigation was started at a moisture extraction level of 50% of the available moisture.